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BULLETIN No 1-B

DRACCO

Is Smoke Responsible For Property Damage?

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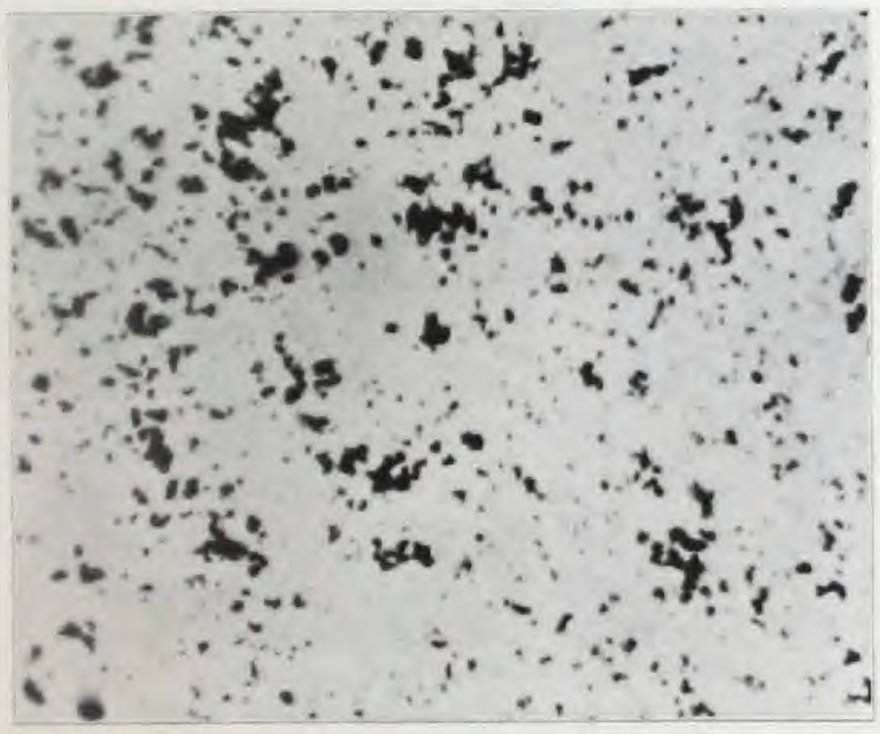


FIGURE 1. Smoke Particles in City Air, Average Size 0.6 Micron. Magnified 1500 Diam. *

FIGURE 2. Silk Damaged by Smoke Particles. Magnified 1200 Diam.

A MAJOR PURPOSE of this article is to demonstrate that atmospheric pollution due to smoke particles in suspension, which range in size from 0.2 to 1.5 microns (a micron is one thousandth of a millimeter), is responsible for property damage to the exterior of buildings, to merchandise in stores, and to interior decorations in homes. Further, it will be demonstrated that the most direct and efficient method of preventing such property damage is to collect smoke at the source of its origin.

The demand for clean air in our cities will not be appreciated as sufficiently imperative until it is realized that there is a necessity for pure air comparable to the demands for pure water and pure foods. Bearing that thought in mind and recalling, further, that the daily consumption of air by the human body is more than four times by weight that of our liquid and solid foods combined, we cannot fail to realize that such air should be clean and wholesome. However, since the consumption of dirty air is not fatal, our attention will be confined to a study of visible manifestations of various kinds of property damage caused by microscopic smoke particles. Atmospheric pollution in large cities has increased to such an extent that owners of merchandising and other buildings, including homes, are resorting in rapidly increasing numbers to cleaning air for ventilating purposes.

When smoke is emitted from chimneys into

* *All Photomicrography by Chas. H. Saylor*

FIGURE 3. Silk Shirt Cuff Damaged by Smoke Particles after One Day's Wear. Magnified 1500 Diam.

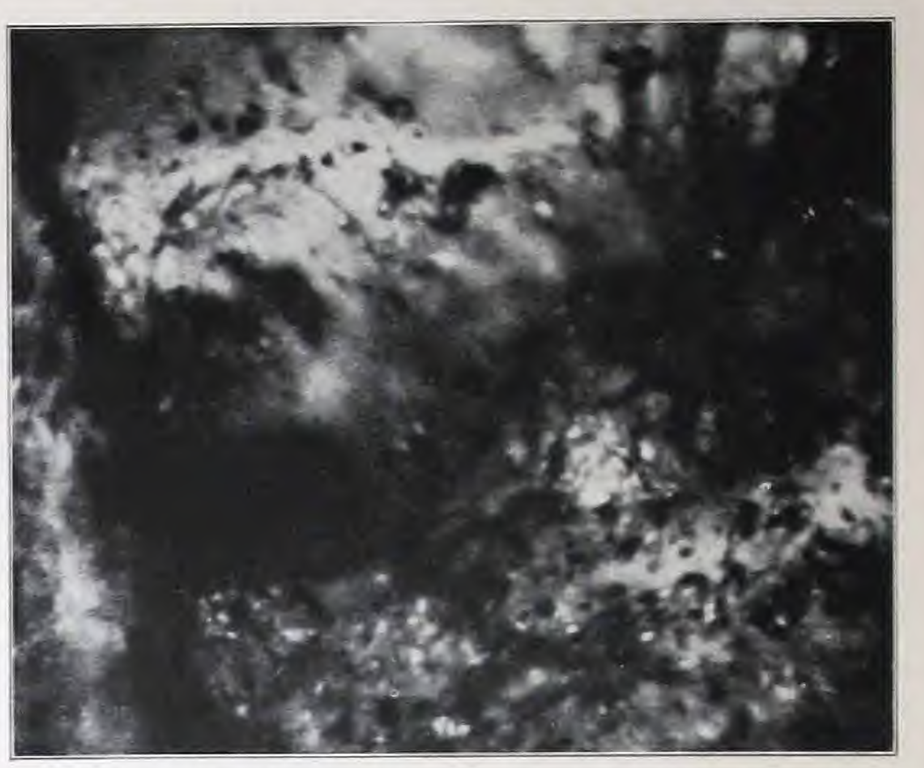


FIGURE 4. Wall Paper Suffers From Smoke Particle Damage. Magnified 1200 Diam.

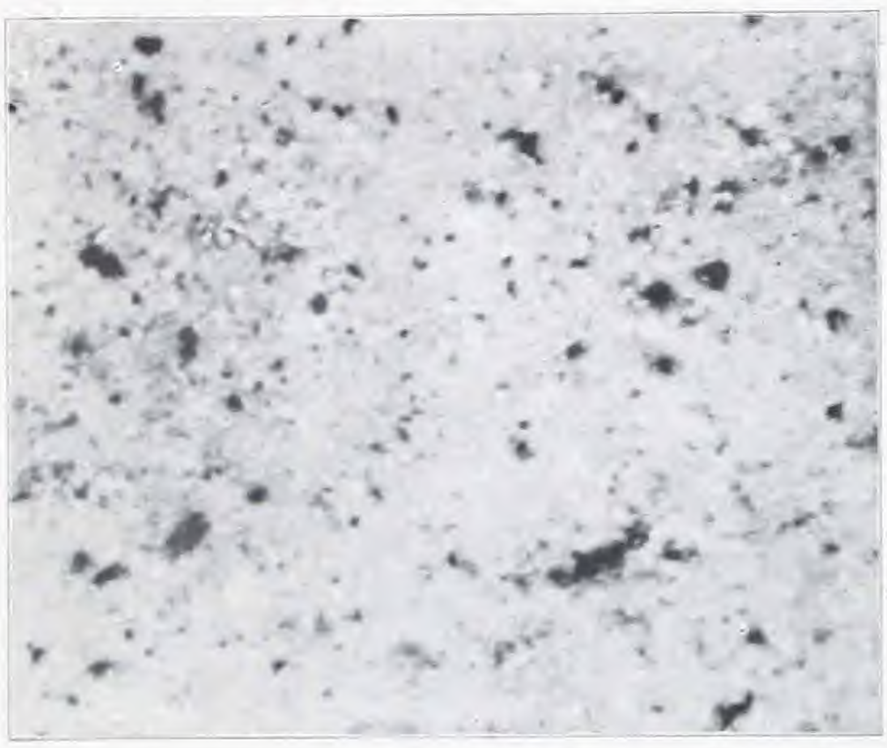


FIGURE 5. Even a Painted Wall is Damaged. Magnified 1200 Diam.

Figure 6. Low Magnification Proves Curtain Injured by Smoke Particles. Magnified 10 Diam.

the atmosphere it becomes dispersed in a very large volume of air, and thereafter the microscopic smoke particles remain in suspension chiefly as individual entities. In other words, there is very little tendency for microscopic smoke particles in suspension to coalesce and form larger particles. Smoke particles in suspension in city air constitute a very dilute aerosol ranging in density from 0.0001 to 0.0006 grain per cubic foot, or averaging about 0.0004 grain. However, the concentration of smoke particles as emitted from power plant chimneys is about 4 grains per cubic foot of air. As a cubic foot of city air contains 0.0004 grain of smoke, and smoke as emitted from power-plant chimneys contains 4 grains per cubic foot of air, it is obvious that there are 10,000 times as many grains of smoke in air per cubic foot at the source of its origin as obtains in air after partial dilution.

If smoke that is emitted into the air were to be collected subsequent to dilution, it would necessitate the cleaning of a volume of air 10,000 times greater than would have been necessary had the smoke been collected at its source. This calculation has been made merely for the purpose of illustrating the wide variation in the concentration of smoke particles encountered in air cleaning for ventilating purposes compared to that in collecting similar smoke particles at the source. Furthermore, it is much more difficult to clean air subsequent to dilution of smoke particles than prior to dilution, owing to the fact that in the former case the smoke particles are in suspension as individual entities, whereas in the latter case the particles are much more concentrated and as a consequence are more easily collected. There is no difficulty in collecting smoke at its source either by electrical precipitation or bag filtration. The latter method is rapidly being recognized as eminently satisfactory.

As the art of air cleaning for ventilating purposes is making rapid progress, it is advisable to analyze the prerequisites necessary to accomplish the desired results in preventing property damage. It is obvious that air cleaning for ventilating purposes has no bear-

ing on the prevention of property damage to the exterior of buildings or vegetation. It is equally obvious that such property damage can best be prevented by collecting smoke at the point of its origin. Although some relief can be secured from property damage to interior decorations and merchandise by air cleaning, such anticipated relief can be obtained only if adequate air-cleaning equipment is employed. Therefore, prospective purchasers of air-cleaning equipment who desire clean air must consider the following essential factors:

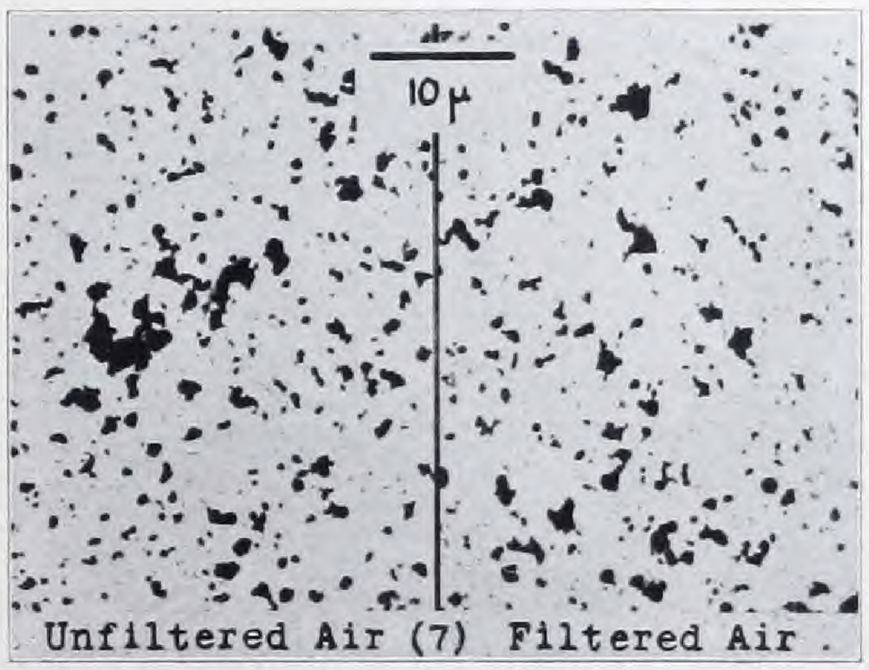
1. What is the size of smoke particles which are in suspension in air and cause property damage?
2. What type of air-cleaning equipment must be employed so that smoke particles will be collected and, as a result, prevent property damage?

The size of smoke particles which remain in suspension in air and cause property damage varies from 0.2 to 1.5 microns. These smoke particles are illustrated by the photomicrograph shown in Fig. 1. This represents smoke particles in suspension in air, the average size of which is 0.6 micron. The particles are magnified 1,500 diameters. Having thus illustrated the size of smoke particles in suspension in air, the next question is, do these microscopic particles cause property damage?

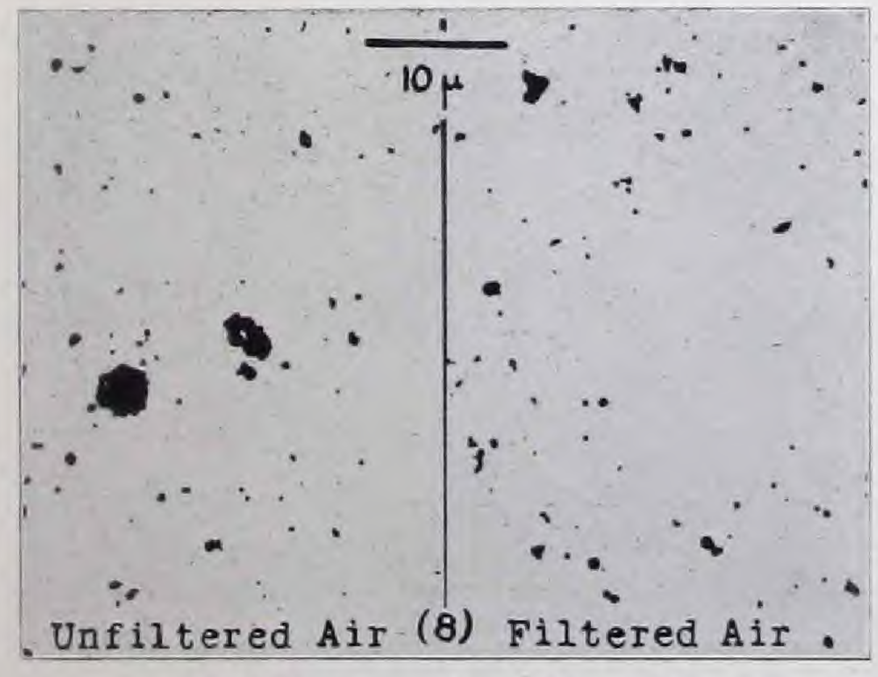
That such microscopic smoke particles as those illustrated do cause property damage is evidenced by Fig. 2, in which microscopic smoke particles have damaged a sample of silk. This sample was suspended in air in the center of the writer's office for several months. From the photomicrograph it will be observed that there are four filaments of a silk thread covered with microscopic smoke particles which have been magnified 1200 diameters. It is evident that these microscopic smoke particles which have damaged the silk are the same size as the smoke particles in suspension in air illustrated by Fig. 1. In other words, this photomicrograph conclusively establishes the fact that microscopic smoke particles suspended in air do cause property damage.

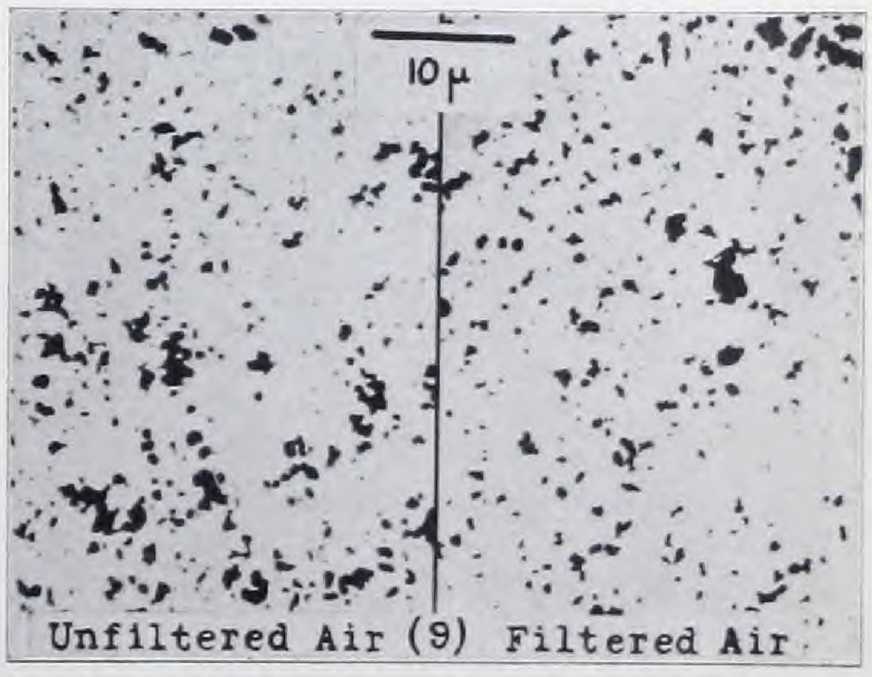
Photomicrograph number 3 is one of a silk shirt cuff taken after the cuff was worn for one day in Cleveland. It will be observed that the microscopic smoke particles in this photograph have been deposited so closely together that they form a continuous film of dirt. In the center of the photomicrograph small particles magnified 500 diameters are in evidence. This damage also is due to smoke particles in suspension which are of the same order as those previously illustrated.

The photomicrograph shown in Fig. 4 represents smoke particles deposited on wall paper and magnified 1,200 diameters. It will be observed that the smoke particles are of the same range of size as those illustrated in Fig. 1. In other words, the microscopic smoke particles which remain in suspension in air have deposited on the wall paper and caused property damage.



A similar condition appears in Fig. 5, which represents microscopic smoke particles deposited on a painted wall and magnified 1,200 diameters. Here again it is apparent that the particles





FIGURES 7, 8 and 9. Air Before and After Passage Through Oil Filter. Magnified 1000 Diam.

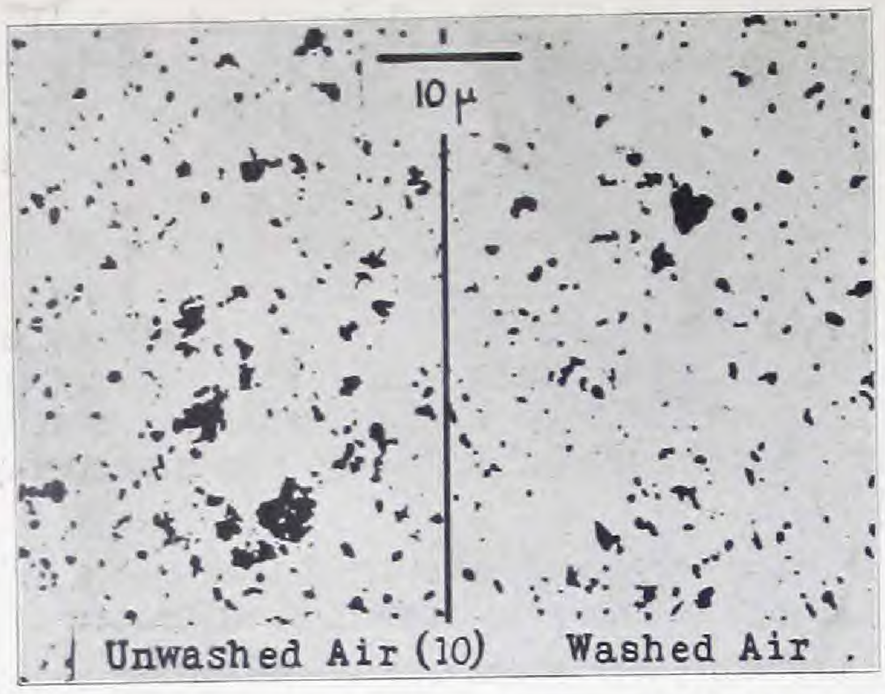


FIGURE 10. Water Washing is No More Efficient Than Oil Filters in Removing Microscopic Particles. Magnified 1000 Diam.

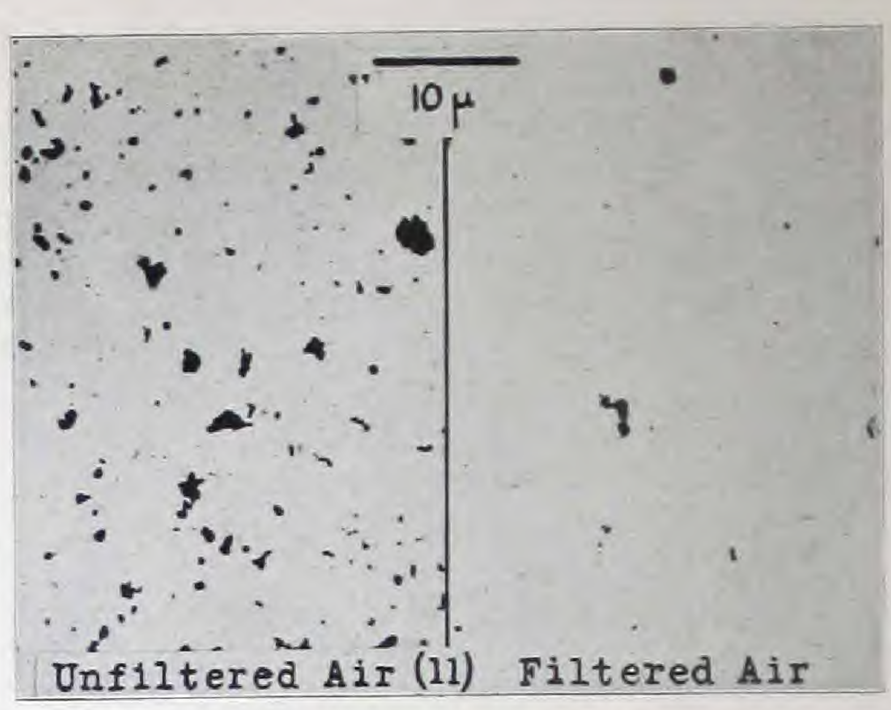


FIGURE 11. Fabric Filter Shown Much More Effective Than Oil Filters and Water Washing. Magnified 1000 Diam. *

deposited on the painted wall are of the same range of size as those which remain in suspension in air, and again have caused property damage.

We need not employ such high magnification to detect property damage. The photomicrograph in Fig. 6 is of a curtain magnified 10 diameters. This curtain was damaged as a result of smoke particles having been blown off a neighboring roof into an adjoining open window in which the curtain was hanging. The damage in this instance was caused by particles of a wider range in size than those illustrated in the previous photographs. Here the particles range from 0.2 to 100 microns.

Without making any attempt to place responsibility on microscopic smoke particles less than 1 micron in size, for the major part of property damage, it will suffice for the present to recognize that property damage is actually caused by smoke particles of less than 1 micron as well as by particles up to 50 or more microns.

WITH the fact established that microscopic smoke particles suspended in air cause property damage to merchandise and interior decorations, the question now arises, how can such property damage be prevented? Obviously, if part of the damage is to be prevented by air cleaning, it will be necessary to employ air-cleaning equipment that will collect microscopic dust particles. In other words, the efficiency of air-cleaning equipment must be determined by its ability to collect smoke particles of less than 1 micron in size.

Thus having imposed certain prerequisites on air-cleaning equipment which may be used for ventilating purposes, it is of interest to consider the following photomicrographs: Figs. 7, 8 and 9, which illustrate efficiency tests made on oil filters; Fig. 10, on a water washer; and Fig. 11 on a fabric filter, all of which are being used for air-cleaning purposes in Cleveland.

The first three photomicrographs of this series represent the air-cleaning efficiency or, in other words, the ability of oil filters to remove microscopic dust particles from air. The fourth represents the air-cleaning efficiency of water washers, and the fifth, the air-cleaning efficiency of a fabric filter.* A cursory examination of these photomicrographs reveals the fact that oil filters and water washers do not remove any appreciable quantity of smoke particles suspended in air, which are less than 1 micron in size. The air samples in the efficiency tests were taken by means of Owens' Jet, and the smoke particles in each are magnified 1,000 diameters. The smoke particles on either side of the vertical line in the photomicrographs represent the number of smoke particles in 0.1 cu. cm. of air.

Although oil filters and water washers do not recover any appreciable percentage of smoke particles from air, they do recover large dust particles and therefore render a service. Further, these inexpensive filters have rendered an indispensable, educational, air-cleaning service in the past which has paved the way for the use of more efficient air-cleaning equipment which undoubtedly will find a more ready sale in the future.

WHAT then are the prerequisites of a dry filter suitable for air cleaning? Obviously, the first prerequisite is that the filter medium shall collect a large percentage of all dust and smoke particles which constitute air pollution. In fact, the efficiency of a filter should be determined by its ability to collect a large percentage of the small smoke particles which range in size from 0.2 to 1.5 microns. Another prerequisite of a satisfactory air-cleaning filter is that the filter medium shall have a large storage or retention capacity for smoke and dust particles, so that the filter may be operated for a considerable period of time without any appreciable increase in resistance to air flow. We have determined that a filter which possesses high porosity and an effective filtering surface 100 times that of its linear surface will remove 90-95 per cent of smoke particles from air as determined by Owens' Jet method.

The photomicrographs which have been submitted here, showing microscopic smoke particles adhering to various kinds of material, constitute incontestable evidence that smoke particles suspended in air, and ranging in size from 0.2 to 1.5 microns, do cause property damage. Furthermore, the quantity of smoke particles which remains in suspension in air greatly exceeds that which settles out due to gravitation, as evidenced by the fact that city air contains from 3,000 to 10,000 or more per cubic centimeter of such particles as are illustrated in Fig. 1. The recognition of these facts is imperative in order to comprehend the prerequisites of air-cleaning equipment, so that property damage may be abated. When these facts are more fully appreciated by manufacturers and users of air-cleaning equipment, the art of air cleaning will advance and the conception that air pollution can best be prevented by collection of smoke at the point of its origin will gain public recognition.

* *Fabric Filter used was a Dracco Filter Cloth*

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